TURBULENCE PICKLING LINES FOR CARBON STEEL
Technology and references
TURBULENCE PICKLING LINES FOR CARBON STEEL

Optimal descaling without over-pickling

Essential for the production of high-quality steel strip with pure, scale-free surfaces is cleaning the strip with acid – technically termed pickling. Newly developed and patented by SMS Siemag, our turbulence pickling process for descaling steel strip with hydrochloric acid has not only proved its worth in many plants, but we also improve the system constantly.

Using our pickling lines, you benefit from high-quality cleaning without over-pickling your steel strip. Furthermore, the process stands out for its low energy and acid consumption as well as low maintenance and operating costs over a long service life.

This turbulence pickling process can be integrated into all lines designed for pickling carbon steel: pickling line/tandem cold mills, continuous, semi-continuous, and push-pull-pickling lines. It is also ideal in strip processing lines for stainless steel and electrical steel strip (silicon steel).

Yet there is more, because apart from turbulence pickling plants, SMS Siemag supplies other advanced components. Just one example is the X-Pact® laser welding machine that joins even hard-to-weld materials.
The mechanical equipment used here, such as tension levelers, loopers, entry and exit sections, is specifically tailored to the conditions in pickling lines.

Our cold rolling mills come in a modular design, complete with high-tech elements such as CVC® plus technology.

Effective and eco-friendly, acid regeneration plants from SMS Siemag Process Technologies recover spent pickling acid and feed it back into the process.

This means SMS Siemag is your one-stop-shop for complete pickling lines including coil logistics, binding strip treatment, laser welding machines, all the mechanical components, as well as drive and control technology.

That ensures you can cut your operating expenses for your overall plant because both your maintenance and spare parts costs are minimized due to perfectly matched components. You also save on customer coordination and training costs.

Read on to learn about the various line types available as well as the key components and technology for pickling lines from SMS Siemag. Then, starting on page 18, you will find a list of some of our reference plants.

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LINE TYPES

Off-the-peg is not our style. SMS Siemag tailors your pickling line to your specific requirements. Depending on the capacity, the steel grades and qualities as well as the strip dimensions you want to produce, your plant comes equipped with the right technologies and components. Generally speaking, pickling lines are available in four types.

**Push-pull-pickling lines (PPPL)**
This is where strips are threaded into the pickling mill individually and pushed or pulled through the process section. The advantages of this discontinuous production method are its great flexibility in terms of production planning and materials that can be processed as well as easy manufacturing of thick strip.

**Semi-continuous pickling lines (S-CPL)**
Stand-out features of semi-continuous pickling lines are the small loopers that ensure the strip in the process section does not have to come to a complete halt while the strips are joined by a stitcher in the entry area. As a result, it is not necessary to re-thread every length of strip. These plants are suitable for small to medium capacities. It’s an added advantage that they can be subsequently upgraded to continuous models.

**Continuous pickling lines (CPL)**
A welding machine at the entry of the continuous pickling line joins individual strips into endless strip, then horizontal loopers ensure continuously high speed in the processing section. That means you achieve top quality standards at very high capacities. Continuous pickling lines can also be coupled to cold rolling mills.

**Pickling line/tandem cold mills (PLTCM)**
What happens here is that these mills continuously pickle and cold roll hot strip in one go. They come with three loopers to ensure a continuous process. Both the entry and exit areas are designed so that the plant can operate continuously at high speed.
Typical plant parameters:
Strip thickness: 1.2 – 16 mm
Strip width: 600 – 2,080 mm
Capacity: 300,000 – 600,000 t/a

Typical plant parameters:
Strip thickness: 1.2 – 6.5 mm
Strip width: 600 – 2,080 mm
Capacity: 350,000 – 700,000 t/a

Typical plant parameters:
Strip thickness: 1.2 – 6.5 mm
Strip width: 600 – 2,080 mm
Capacity: 1,500,000 – 2,700,000 t/a

Typical plant parameters:
Entry: 1.2 – 6.5 mm
Exit: 0.3 – 3.5 mm
Strip width: 600 – 2,080 mm
Capacity: 1,500,000 – 2,500,000 t/a
ENTRY AREA

Easy threading in with short downtimes

SMS Siemag supplies high-quality mechanical equipment for the entry area of hot strip mills that can be equipped with one or two payoff reels or with one payoff reel and one support reel for coil preparation. Included here are:

- Coil lifter in an extremely flat, robust design
- Coil preparation station for removing faulty or difficult strip ends (e.g. fishtails) and for bending a slight lift that makes threading in easier

HORIZONTAL STRIP LOOPERS

Keeping the process moving

Vital here are the horizontal loopers. They ensure a constant strip speed in the process section of the plants. Depending on the plant type, two or three loopers are installed that are often more than 100 m long and collect over 500 m of strip in up to six layers.

The loopers fill up and empty due to the action of looper cars that travel at speeds of up to 150 m/min. The strip in the carriages is guided by as many as three rolls.

Built in to this system are swivel gates to support the loops of strip in the loopers. Whenever the loop carriages travel over switching curves, the gates open and close mechanically. To regulate the strip position in and after the horizontal loopers, separate strip centering devices are installed.
**SCALE BREAKER**

**Descaling and improving strip geometry**

Next in line is the scale breaker (also called tension leveler). It breaks up and removes some of the scale from the strip and prepares the surface for the pickling process. Moreover, it increases strip flatness and removes any sabers. Then the strip can travel through the narrow turbulence pickling tank – smoothly and without catenary.

S-roll units are installed both upstream and downstream of the scale breaker to stretch the strip to the necessary tension of up to 600 kN. To save energy, the rolls of the two units are coupled by a mechanical tensioning system. Bending rolls bend the strip in both directions several times at a relatively high strip tension. This breaks up the scale and improves strip geometry.

Also important at this stage is the correction roll unit in the bending roll stand that eliminates any cross cambers resulting from longitudinal stretching of the strip grain. The broken scale is blown off and extracted using compressed air.

**INTEGRATED SCALE SUCTION CONCEPT**

A newly developed, integrated suction concept minimizes scale dust problems in the entry area of pickling plants, while simultaneously reducing the suction power. Your bottom line: Low exposure of employees to dust, less susceptibility of the plant to disruption and wear, and reduced dust emissions.

All that makes your plant simultaneously safer, more effective, and greener. Optimized after extensive process and flow studies, this development improves suction or collection features at all the critical points. These devices operate with powerful fans linked to a central system.

**Key features:**

- Reduction of volume flows of the individual suction hoods with simultaneous improvement of scale removal
- Optimized distance between suction hoods and strip
- Suction hoods with active blow-off system that picks up the dust and transports it to the hoods
SMS SIEMAG
LASER WELDING MACHINE

Precise, fast welding

The innovative laser welding machine has been up and running since 2008. It has proved invaluable for precise, rapid joining of hard-to-weld thin and high-alloy strip – which is then perfectly prepared to travel smoothly through the process. As a result, even high-carbon strip such as C 67 can be treated in a continuous line.

Two further laser welding machines have been successfully in operation at ThyssenKrupp Steel USA and Tokyo Steel, Japan since 2011.

Moreover, there were two new orders for SMS Siemag to supply laser welding machines for pickling tandem lines to JSW, India, and Hyundai Hysco, Korea.
Automatic adjustment of welding parameters and inductive pre and post-heating of seams

The compact welding machine comes with many innovative features. Take for instance the automatic adjustment of the welding parameters to new material pairings, controlled by an analysis of the melting characteristics.

Even difficult material combinations are possible with our patented inductive pre and post-heating of the weld seam. That’s how an excellent microstructure develops in the heat-treated zone with a homogeneous weld seam quality. An integrated weld seam analysis system fully automatically checks the seam before, during, and after welding.

Reliable welding process

Crucial here is that the individual strips are positioned in relation to each other without any offsetting or angles. This is where a shifting function comes in. It aligns the head end of the new strip with the end of the previous strip.

The integrated shear is a cross-cutting shear. To take account of different strip thicknesses, the stroke can be adjusted between center, top, and bottom.

The welding process takes place using a sliding carriage fitted with the laser head and pre-heating inductor. The inductor for post-heating is mounted on a separate undercarriage, which means that the delay between welding time and post-treatment can be set variably.

To ensure the vibrations of the carbon dioxide laser resonator do not impair its welding accuracy, it rests on its own foundations.

Simpler commissioning

The laser welding machine is completely assembled and commissioned in the SMS Siemag workshop. Here is where we test all the functions of the main machine.

We also use this opportunity to train the maintenance and operating personnel who will work on the machine in the future while it is fully operational. This makes commissioning simpler.
THE TURBULENCE PICKLING PROCESS FROM SMS SIEMAG

Efficient descaling without over-pickling
The turbulence pickling process from SMS Siemag stands out for its high pickling performance, low energy and acid consumption, as well as low maintenance and operating costs over a long service life.

All the key pickling process parameters can be actively controlled and perfectly adjusted to current requirements. This is how the process achieves optimum pickling results at low energy consumption. Due to the constant analysis of the pickling process, expensive chemicals are not needed to prevent damage to the base material.

Plastic pickling tanks, cascade rinsing unit, air drying
As a rule, high-performance SMS Siemag pickling lines consist of three to four pickling tanks. They each feature their own circular system, are made of plastic or rubber-backed steel, and come in a modern, lightweight design. The cascade rinsing unit cleans the strip surface and removes residual acid, followed by hot air drying.

Shallow pickling channel and patented immersion covers
The extremely shallow design of the pickling channel and the horizontal position of the strip explain why the tank volumes are very small. There is a patented immersion cover above the pickling channel that closes off the acid bath surface. This is how we minimize evaporation and associated energy losses.

High turbulence
Racks of nozzles in the shallow channel constantly spray heated hydrochloric acid, generating extremely high turbulence. That ensures maximum contact between the pickling acid and the entire strip surface by continually forcing fresh acid into the cracks in the scale layer. It only takes a very short time to create the electrochemical potential required for the pickling process. Furthermore, the destruction of the laminar top layer on the strip surface greatly improves not only the material exchange, but also the heat transfer. Both of these processes increase the effective pickling time. That means increased strip speed at the same tank length.

Minimized acid evaporation and energy losses - the patented immersion cover.
A hydrodynamic sealing separates the acid cascades and ensures exact gradation with a minimum of mechanical components.
**Turbulence control and hydrodynamic sealing**

Frequency-controlled centrifugal pumps generate the turbulence. That makes it possible to adjust the turbulence independently of the strip speed, actively influencing the pickling process. There are hydrodynamic seals separating the individual acid cascades, providing for exact adjustment of the acid concentration and optimal acid utilization. The acid runs through the cascade counter to the strip direction so that the cleanest acid is in the last pickling tank.

**Recuperator tank**

The acid can also be utilized in the patented recuperator tank arranged upstream of the first pickling tank. Here, used pickling acid is sprayed onto the strip as it enters. This removes loose scale particles and heats the strip. What’s more, the process chemically activates the surface, speeding up the subsequent pickling stage. Not only does this optimize the pickling result and save thermal energy, it also cuts acid consumption because no loose scale particles go into the acid cascade.

**Process model**

The pickling process in a turbulence pickling plant can be optimized using a process model. Such a model keeps the acid temperature as low as possible and avoids disruptions to the process caused by changing production speeds. To do this, the model determines the optimal pickling parameters 10 to 20 coils in advance and controls the transitions between coils for the required pickling result every time. This is how the model reduces acid and energy consumption while also increasing the service life of the components exposed to acid.
ACID REGENERATION PLANTS
from SMS Siemag Process Technologies

An increasingly important factor for any new pickling plant is compliance with environment protection regulations, plus high energy efficiency. Plants for spent acid regeneration are an outstanding example of green and efficient technology. It’s not just the regenerated acid they put back into the steel strip pickling process. These systems also produce valuable by-products that can be marketed separately. That creates a closed material cycle. Furthermore, what makes regeneration plants stand out is their excellent energy efficiency. SMS Siemag Process Technologies of Vienna, Austria, supplies acid regeneration plants developed specifically for pickling technology.

**Fluidized bed acid regeneration plant**

The first stage in this pyrohydrolytic process is breaking down the spent acid into its chemical components in a heavy fluidized bed furnace at around 850 °C. One component is iron oxide granulate which is continually removed from the furnace floor. Because the iron oxide granulate from a fluidized bed regeneration plant is ideally suited to in-house smelting, this process is frequently used by customers who operate their own blast furnace.

The waste gas from the fluidized bed furnace is cooled in a Venturi evaporator. Next in line are process stages in which the hydrogen chloride gas is washed out with rinsing water.

**Spray-roasting process**

The spray-roasting process consists of three main steps: pre-concentration, roasting, and absorption. This is another pyrohydrolytic process, but here the acid is roasted and broken down at a temperature of some 650 °C. The treatment, which takes place under the influence of heat and gases, generates re-usable acid and iron oxide dust.
Future technology:
Hydrothermal acid regeneration

Focusing on hydrothermal acid regeneration, SMS Siemag is developing a new acid treatment process that promises significant economic and ecological advantages.

Take for instance energy consumption. The closed process that takes place at temperatures of between 70 and 170 °C uses up to 50 percent less energy than conventional solutions. Furthermore, it generates very high-quality recovered products.

The treatment consists of three main stages: First, the spent acid is concentrated at low temperatures under vacuum, during which free hydrogen chloride (HCl) and water evaporate from it. The second step is oxidation of the iron (II) chloride under high pressure with pure oxygen to make iron (III) chloride. The third step is low-temperature hydrolysis. Here, the concentrated iron (III) chloride solution is converted into iron oxide and hydrogen chloride.

While special filters remove the iron oxide from the solution, the rest evaporates. Finally, the evaporated acid condenses into regenerated acid together with the distillate from the concentration stage.

In a hydrothermal acid regeneration plant, the acid is recovered in three process steps.
ASC SIDE TRIMMER

High cutting performance and permanent availability

It is the job of the ASC (Automatic Setting Control) side trimmer to straighten the edges and trim the strip precisely to the required width. There is a major advantage of the double-headed side trimmer, because the trimming blades in the maintenance position can be changed during ongoing production. The circular blade units are equipped with a combined blade gap setting for the blade cover and gap. As it is being trimmed off, the edge is continually chopped into small pieces by a cutter and removed by a conveyor belt.
**DUMA-BANDZINK OILING MACHINE**

**Electrostatic coating**

To protect the strip surfaces, the electrostatic Duma-Bandzink oiling machine applies a film of oil cleanly and evenly to both sides. Because the oil droplets are applied electrostatically – therefore contact-free – the machine does not affect the strip transport or damage the strip. Using servo-controlled metering pumps, the oiling machine guarantees unvarying oil application even when process speeds change.

![Duma-Bandzink oiling machines are designed to customer specifications – already more than 270 machines have been fitted.](image)

**EXIT AREA**

**Reliable coiling with short downtimes**

The exit area of the pickling line features one or two coilers that ensure perfect coiling with short downtimes.

First, a cross-cutting shear cuts the strip to length in the exit area. This is where the weld seams can be cut out and samples taken. Next, after the shear, comes a strip centering device that ensures the start of the new strip is placed in the center of the reel mandrel. A deflecting plate helps thread the strip into the clamping slot of the reel mandrel.

The coiler is mounted on a slide, and it has a mandrel with a center spreading clamping slot.

Alternatively, the plants by SMS Siemag feature a belt wrapper, which supports the first windings of the strip around the mandrel. In this way the strip can be wrapped without any clamping.

While a counterbearing supports the reel mandrel, the strip is coiled aligned either in the middle or at the edge. Finally, the coils are placed on a coil transporter, tied with straps and transported away.

![Single exit area in a continuous pickling line with strap winder and coil transport system.](image)
SMS Siemag launched its first pickling line/tandem cold mill (PLTCM) in 1979. So far, we have erected and successfully commissioned 30 plants of this type worldwide.

**Cost-effective plant operation for high production performance**

Coupling a pickling line with a tandem cold mill (TCM) to achieve continuous production opens up scope for an annual production capacity of up to 2.5 million t of cold strip. The economic advantages of the PLTCM design result from a smooth production flow, lower roll wear, higher yields, and consistent product quality.

**Wide product range for soft and high-strength grades**

Tandem cold mills process strips in widths from 700 to 2,100 mm with an initial thickness of up to 6.5 mm, rolling them to a minimum final thickness of 0.1 mm. There is a wide spectrum of suitable materials – from soft IF steels to high-strength grades.

Usually, the modern coupled TCMs from SMS Siemag consist of five consecutive mill stands in four or six-high design. We also supply special constructions for specific applications. Included here is our CVC® plus M18/4 multifunction rolling mill for processing soft to high-strength grades as well as stainless steels in a single plant.

This type of stand ensures flexible, cost-effective production of even small batches.

**Advanced mechanical and electronic systems for excellent strip quality and efficient plant operation**

Practice-proven and innovative technological control elements in the mill stands reliably produce the required cold strip properties such as strip thickness, flatness, and surface purity. Standard features of SMS Siemag mill stands are CVC® plus, roll bending and EDC®, which guarantees a constant strip thickness right to the edges. Installed in the final mill stand, a multi-zone cooling feature optimizes flatness, while the T-Clean Dry-Strip System efficiently dries the strip surface.
Depending on the plant design, either a double reel unit or a carousel reel for continuous coiling of the finished strip are available. There is also the option of an inline or offline inspection station for production-near quality control. Rotary Inspect, the latest inspection system from SMS Siemag, is ideal for checking both strip sides easily and thoroughly during ongoing operation.

The perfect performance of the TCM is the result of the smooth interaction between mechanical equipment, electronics, and automation. X-Pact® Level 1 to 3 for SMS Siemag tandem cold mills is perfectly geared to the specific process technology applied here. All control and regulation functions are integrated on the X-Pact® Embedded hardware platform with the common logi.CAD programming environment. Level 1 contains the technological regulation systems for thickness and flatness as well as the especially user-friendly HMI. Then there is Level 2 with the technological process models for reliable setting of the rolling mill and recording the production data, as well as for reporting. Level 3 provides the plant operator with all the necessary tools for planning and control of the production processes.
GLOBAL REFERENCES

175 pickling lines from SMS Siemag worldwide

SMS Siemag has supplied and erected 175 pickling lines for carbon steel for many of the world’s leading steel manufacturers. So far that includes a total of 125 continuous pickling lines and pickling line/tandem cold mills. We have also supplied 50 push-pull-pickling lines for our customers on all continents. First installed in 1985, as many as 55 of our turbulence pickling systems were implemented in continuous pickling lines or push-pickling lines for carbon steel, electric strip, and stainless steel. Each of these plants was designed, erected, and commissioned according to our customers’ wishes. Read on for some examples of plants with details of their special features plus technical facts and figures.

The process is continually monitored.  
In 2008, Shougang Jingtang ordered a pickling line/tandem cold mill for more than 2 million t of cold strip per year. It went online as early as 2010.  
The continuous pickling line at Jinan in China produces more than one million t of pickled and oiled hot strip per year.
More than one million t of cold strip per year: the pickling line/tandem cold mill at Severstal Columbus, USA.

For the new ThyssenKrupp Steel USA complex in Calvert, Alabama, SMS Siemag installed a pickling line/tandem cold mill (2.5 million t/a) and a continuous pickling line (1.1 million t/a).

Pickling line/tandem cold mill for MMK, Russia with an annual capacity of more than 2 million t of cold strip.
PICKLING LINE/ TANDEM COLD MILL
at Baosteel

Pickling line/tandem cold mill for cold rolling complex No. 5

It started up ahead of schedule and passed the acceptance tests with flying colors. That was why Baoshan Iron & Steel Company issued SMS Siemag with the approval certificate for the pickling line/tandem cold mill at an early date, in April 2009. Ever since, the plant has been producing materials including high-quality, high-strength cold strip for automotive panels. The strip is also used in the construction industry or for electro-technical applications. Commissioning and start-up went like a dream. Not only was the production line put into operation two months before the scheduled deadline, but the optimization phase was also short and wrapped up successfully with the final approval tests.

Third pickling line/tandem cold mill for Baosteel

The five-stand pickling line/tandem cold mill is the fifth plant SMS Siemag has supplied for the Baosteel cold rolling complex in Shanghai. Also included in the package were a continuous annealing line and several strip processing plants. This was the third pickling plant from SMS Siemag for the Baosteel group.

Highlights of the pickling line

A double payoff group optimizes the coil infeed times in the entry area, increasing the plant flexibility. Then the integrated scale breaker breaks up the scale and shortens the pickling process. That improves strip flatness so that the strip runs smoothly into the pickling channel. Equipped with turbulence technology, the pickling section stands out for excellent effectiveness at minimized operating costs. It is important to keep the generation of acid vapor as low as possible. This is where the patented immersion cover comes in, because it seals off the acid bath in the pickling channel. Right in the exit area, there is an automatic ASC side trimmer with a time-saving rapid changeover system for the blades.

High-tech components in the tandem rolling mill

All five six-high stands in the pickling tandem mill feature our CVC® plus technology. They are built in our practice-proven modular design. A multi-zone cooling system in the final mill stand ensures the ultimate strip flatness. Next in line, the Dry-Strip-System produces a dry strip surface free of emulsion marks. That happens entirely contact-free, while the strip is protected from the emulsion by a precisely controlled air flow. The carousel coiler in the exit area of the tandem mill effects fast coil changes. Finally, the strip inspection line makes quality control easy and reliable. This ensures the strip quality meets high customer requirements.

A finished coil is transported away while the carousel coiler is already winding the next coil.
The strip enters the pickling tank.

The scale breaker breaks up the scale for better strip geometry.

Inspection of the pickled strip.

**Baosteel**

<table>
<thead>
<tr>
<th>Commissioning</th>
<th>2008</th>
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<tbody>
<tr>
<td>Material</td>
<td>CQ, DQ, DDQ, EDDQ, SEDDQ, HSS, BH, DP, TRIP</td>
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<td>Strip width</td>
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<td>Strip thickness (entry)</td>
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<td>Strip thickness (exit)</td>
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<td>Capacity</td>
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<table>
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<tr>
<th>Speed:</th>
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<tbody>
<tr>
<td>Entry</td>
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<tr>
<td>Process</td>
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<tr>
<td>Exit</td>
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</table>
PICKLING LINE/TANDEM COLD MILL
for China Shougang Corporation

Green technology for high-quality cold strip

The China Shougang Corporation is setting new standards in Beijing with its clean plants from SMS Siemag, not least when it comes to green technology. Shougang has decided not to extend its old works complex in the west of Beijing and has relocated to the east of the city. This is where a consortium headed by SMS Siemag erected a state-of-the-art pickling line/tandem cold mill and a continuous annealing line for high-quality cold strip with excellent deep-drawing properties. Now Shougang can produce some 1.8 million t of deep-drawing cold strip on its new production plants.

Turbulence pickling section

The line starts with a payoff group consisting of two coilers. Next, the laser welding machine creates the endless strip that is fed into the entry looper at speeds of up to 700 m/min. A scale breaker breaks up the scale ready for the pickling process. Then the strip enters the turbulence pickling section at a rate of 230 m/min. The triple benefits: low acid consumption, low acid temperature, and high pickling effectiveness. What makes this possible is the turbulence pickling process with its shallow pickling tanks and patented immersion covers. Downstream, the rinsing and drying units remove residual acid and dry the strip. Next in line are another horizontal looper, a side trimmer, and an inspection station.

Tandem mill

Another looper after the inspection section stores strip between the plant parts. Leaving the looper, the strip travels through the five-stand rolling mill. There it is rolled to its final thickness under a maximum rolling force of 33 MN. The mill stands are of a six-high construction type – featuring work, intermediate and backup rolls. Each stand is equipped with the very latest rolling technologies.

Included here are CVC® plus components as well as interim and work roll bending devices. The result: a flat strip surface and strip thicknesses within narrow tolerances. The plant’s green credentials are underlined by the rolling emulsion removal and regeneration systems. Next, the rotary shear cuts the strip into lengths at high speed. These are then coiled on a compact carousel coiler.
China Shougang Corporation PLTCM

- **Commissioning**: 2008
- **Material**: CQ, DQ, DDQ, EDDQ, SEDDQ, HSS, BH, DP, TRIP
- **Strip width**: 800 to 2,080 mm
- **Strip thickness (entry)**: 1.6 to 6.0 mm
- **Strip thickness (exit)**: 0.2 to 2.5
- **Capacity**: 1,870,000 t/a
- **Speed**:
  - **Entry**: 700 m/min
  - **Process**: 230 m/min
  - **Exit**: 1,400 m/min

**Double entry area and strip flattener with scale extractor.**
COUPLED PICKLING LINE/TANDEM COLD MILL at Tianjin Tiantie

More than 1.6 million t of cold strip per year

Following successful approval tests, in September 2008 Tianjin Tiantie Metallurgical Group Steel Plate Company in Tianjin, north-eastern China, put its first coupled pickling line/tandem cold mill into continuous production. The cold strip manufactured here is mainly used in the automotive and white goods industries. Previously, in March 2006, Minmetals International Tendering Co. awarded the contract for construction of the plant to a consortium led by SMS Siemag.

Approval four months after commissioning

The first strip rolled off the plant in May 2008. During this first campaign, 660 t of strip was pickled and rolled. That is equivalent to a production rate of approx. 290 t/h, significantly higher than the specified target figure of 274.5 t/h. According to the availability of the strip types to be processed, almost 90% of all the approval tests were successfully completed by the end of July 2008. Finally, in September, just four months after commissioning, the plant was fully optimized, the approval tests passed, and the customer approval granted. The plant also fully met the required parameters such as gage performance, off-gage-length, and flatness performance.

Scope of supply and services

Included in the supply scope of SMS Siemag were the design and supply of mechanical equipment for the entire plant, as well as supervision of installation and commissioning. Equally crucially, we were responsible for coordinating all deliveries and work by the consortium members.

Continuous process

To guarantee the continuous process that significantly increases the product quality while slashing energy consumption, the plant features a laser welding machine and three horizontal loopers. Among the components SMS Siemag supplied for the pickling section were a scale breaker with clamped drive system, a turbulence pickling plant with pickling model, and a side trimmer. The turbulence pickling plant features our patented energy-saving immersion covers. They ensure compliance with tough environment regulations. Also part of our supply scope were the mill stands with CVC® plus technology, Dry Strip System, and modular stand piping, as well as a rotary shear and carousel coiler.
## Tianjin Tiantie PLTCM

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<tr>
<td>Exit</td>
<td>1,250 m/min</td>
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</table>

The strip travels through the process section at a continuous speed of 220 m/min.

- **Entry section**: Scale breaker.
- **Side trimmer with blade changing device**
CONTINUOUS PICKLING LINE
WITH ACID REGENERATION
at Salzgitter steel production location

Top productivity and flexibility

Salzgitter Flachstahl GmbH is the largest subsidiary of Salzgitter AG. It manufactures a wide range of conventional and innovative flat products geared to customer requirements. This explains why Salzgitter Flachstahl insists on top plant technology. SMS Siemag installed a new continuous pickling plant that provides the strip with flawless surfaces in preparation for the downstream processes.

Technological highlights

Salzgitter defined very special requirements of the technology and capabilities of the plant. Included among the highlights is the high capacity of 2.5 million t per year. The plant can handle a huge product range, also covering innovative, high-strength and high-yield-strength steel grades.

Developed by SMS Siemag, the laser welding machine easily deals with this extremely challenging product mix. It produces grades such as C60 and C67. To cope with the high speed of 650 m/min in the entry area, the plant features loop carriages that can move at rates of up to 145 m/min.

Plant components

Essentially, the plant consists of two payoff reels, an SMS Siemag welding machine, a horizontal entry looper, a tension leveler, a turbulence pickling section with four pickling tanks followed by a cascade rinsing unit and dryer, an exit looper, a side trimmer, an inspection station, an oiling machine, and a coiler. It also comes with a whole raft of measuring, control, and surface inspection systems, as well as equipment for labeling and packaging.

Fluidized bed acid regeneration

You can imagine that, in a pickling line of this capacity, large quantities of used hydrochloric acid and rinsing water are generated. That’s why SMS Process Technologies added an acid regeneration plant.

It uses the fluidized bed process to regenerate up to 12 cubic meters of spent acid per hour with a recovery rate of almost 100 percent.

Without this plant, the pickling line would need to be refilled every day with many truckloads of acid. Yet it’s not only about the acid. The regeneration plant also recovers the iron removed from the strip. This can then be recycled in the form of iron oxide granulate in further steel production.
### Salzgitter CPL

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
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<tr>
<td>Commissioning</td>
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<td>Strip thickness</td>
<td>1.5 to 6.0 mm</td>
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<tr>
<td>Capacity</td>
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**Speed:**
- Entry: 650 m/min
- Process: 250 m/min
- Exit: 500 m/min

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View of the plant from the entry side.

Exit section.

Circulation tank.
CONTINUOUS PICKLING LINE WITH ACID REGENERATION PLANT for Tokyo Steel

August 2011 saw the first strip processed on the continuous turbulence pickling line SMS Siemag had erected for Tokyo Steel in Japan. Operating in continuous production, the pickling line achieves an annual capacity of 1.8 million t. Right from the start, the plant foundations were designed to allow for a possible future coupling with a tandem mill. Furthermore, SMS Siemag Process Technologies installed an acid regeneration plant that uses the spray-roasting process to regenerate 10,000 liters of acid per hour from the pickling plant and to feed it back into the process.

Flatness. Incidentally, the scale breaker at Tokyo Steel is the first of its type to feature completely hydraulic regulation. That means it can be adjusted very flexibly.

Recuperator tank

Now, before it enters the turbulence pickling tanks, the strip runs through the patented recuperator tank where it is sprayed with used acid from the pickling process. This pre-cleaning removes above all large pieces of scale so that they do not go into the pickling tank and contaminate the pickling acid. Moreover, this stage pre-heats and activates the strip.

Turbulence pickling section

Each of the three turbulence pickling tanks is 35 m long and equipped with racks of nozzles that spray acid heated to 80 - 85 °C into the shallow pickling channel. This section is followed by a 20-meter cascade rinsing unit. Then the strip is dried with hot air.

Plant components

Two entry coilers, a laser welding machine, horizontal entry looper, scale breaker, turbulence pickling section, horizontal exit looper, side trimmer, Duma-Bandzink oiling machine, flying crank shear, and two coilers.

Tokyo Steel in Tahara

The new Tokyo Steel complex in Aichi Prefecture on the Atsumi peninsula mainly produces flat products. These materials are destined above all for the automotive manufacturing works in the industrial region around Toyohashi.

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Tokyo Steel CPL

<table>
<thead>
<tr>
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<th>Value</th>
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<tbody>
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<td>Strip thickness</td>
<td>1.5 to 6.0 mm</td>
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<td>Capacity</td>
<td>1,800,000 t/a</td>
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</table>

**Speed:**
- **Entry:** 700 m/min
- **Process:** 280 m/min
- **Exit:** 450 m/min

The hydraulically controlled scale breaker breaks up the scale on the surface and increases flatness.

Open turbulence tank with immersion covers.

View of the scale breaker and entry area in the turbulence pickling section.

Entry area of the continuous pickling line.
New cold rolling complex for Gazi Metal

Gazi Metal Mamüleri contracted SMS Siemag in April 2011 to supply a new cold strip production plant near the town of Karazu in Turkey. Starting in 2013, it will produce carbon and silicon steel strip, achieving an initial total capacity of 350,000 t/a. Gazi Metal Mamüleri is set to supply for instance the automotive industry and manufacturers of household appliances. SMS Siemag will supply all the core components along with drive technology and automation. Included in the supply package for the first stage are a semi-continuous pickling line with integrated acid regeneration plant, a CVC® plus six-high reversing cold rolling mill, and a skin-passing mill in four-high construction type.

Semi-continuous pickling line

The entry area of the semi-continuous pickling line features two payoff reels and one stitcher that joins the individual strips. Next in line, the process section consists of a 35-t tension leveler and a turbulence pickling section containing three 18-meter plastic pickling tanks, a 5-stage cascade rinsing unit, and a strip dryer. Finally, the pickled strip goes through a side trimmer, an inspection station, and a Duma-Bandzink oiling machine before it is cut by a cross-cutting shear and coiled on a coiler using a belt wrapper.

Integrated before and after the process section are two horizontal loopers with looper carriages. During stoppages in the entry and exit areas, they can supply strip to the process or take up strip from the process. These loopers are designed to ensure the process can always run at a speed of at least 30 m/min.

Already planned is a second stage which will convert the plant from semi-continuous to continuous operation, and all the requirements for this were created right from the start. The upgrade will involve extending the two horizontal loopers and integrating a laser welding machine into the entry area. Then it will be possible to transport the strip through the process at a permanent speed of 140 m/min, doubling the capacity of the plant. The maximum speed in the entry and exit areas will increase to 220 m/min.
Fluidized bed acid regeneration

To recondition the used, iron-enriched hydrochloric acid from the pickling process, SMS Siemag Process Technologies is supplying an acid regeneration plant. It is designed to regenerate 1,700 l/h, coping with all the acid consumed by the semi-continuous pickling line. Operating according to the fluidized bed process, the plant is equipped with the latest technology for emission control and energy consumption optimization.

Once the second construction stage has been completed, a second plant with the same capacity will be installed to regenerate the doubled volume of acid used in the continuous pickling line.

Gazi Metal Mamülleri S-CPL

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<td>Capacity</td>
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Exit side of the pickling line.

Entry area with two payoff reels and a stitcher.
Push-pull-pickling line successfully commissioned

In November 2011, the new push-pull-pickling line at Severstal Columbus successfully produced its first coil. Using this plant, the company can now pay off, level, pickle, trim, and re-coil hot strip in widths of up to 1,880 mm. The up to 12.7-mm thick strips travel discontinuously through the plant at a rate of as much as 152 m/min. Included in the planned range of materials are soft deep-drawing grades, IF steels, and modern high-strength steels. The annual capacity achievable with this material mix is 540,000 t.

Flexible production

There are three main benefits of the discontinuous production method: great flexibility in production planning, a wide range of materials, and the easy production of thick strip. It is not necessary during production planning to take account of the different geometrical dimensions and qualities of subsequent strips because they are not welded together. That means even steel grades that are difficult or impossible to weld can be processed.

Plastic tanks

A special feature of the plant are the pickling tanks made of plastic in the turbulence pickling section. There are granite blocks on the walls and floor to protect the tanks from mechanical wear. The advantages of plastic tanks are their light weight and easy installation. Unlike conventional solutions with granite blocks, bricks, cement, acid-resistant rubber, and steel, the plastic tanks do not require masonry or cementing work.
Turbulence pickling section

Looked at in terms of the process, turbulence pickling technology in push-pull-pickling comes with the following advantages:

- The strip runs through a completely enclosed, shallow granite channel. Due to the V-shaped granite profile, even thin and soft steel strip is safely transported during feeding in. The heavy granite covers prevent the strip from buckling and support the feed-in process.

- The high turbulence in the narrow pickling channel intensifies the pickling process and shortens the pickling time. Because the turbulence pickling channel is completely filled with acid, the steel strip is covered from the entry to the exit.

- The granite covers are immersed in the acid and seal off the evaporation surface, minimizing heat and acid losses caused by evaporation.

- The hydrodynamic sealing minimizes the acid quantities on the squeezing rolls. This prevents that acid escapes from the squeeze rolls out of the tank.

Severstal Columbus PPPL

<table>
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<th>Commissioning</th>
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<tbody>
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<td>Material</td>
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<td>Speed:</td>
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</table>

SMS Siemag erected the entire works for Severstal Columbus – consisting of not only the push-pull-pickling line but also a pickling line/tandem cold mill (see box).
REFERENCES SINCE 2000

Pickling lines for carbon steel

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<tr>
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</table>
MEETING your EXPECTATIONS

SMS SIEMAG AG
Strip Processing Lines Division
Walder Strasse 53
40724 Hilden, Germany
Phone: +49 211 881-4618
Telefax: +49 211 881-4212
E-mail: strip.processing@sms-siemag.com
Internet: www.sms-siemag.com

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